

TAXONOMY AND THE PROBLEM OF PHYSIOLOGICAL  
VARIATION AMONG MORPHOLOGICALLY INDISTINGUISHABLE NEMATODES<sup>1/</sup>

J. G. Baldwin

HISTORY:--Taxonomy is derived from Greek words which literally mean "the law of arrangement", but it has been more precisely defined as "the theory and practice of classifying organisms" (7). Previously, the major goal of classification was to produce identification schemes based on morphological traits (7). However, in the nineteenth century evolutionary theory began to greatly influence taxonomy, and biologists sought to build a classification system which reflected their understanding of evolutionary development (1, 7). Further research disclosed that taxonomic groups differ not only morphologically, but ecologically, geographically, physiologically, behaviorally, cytologically, genetically, and even molecularly (viz serologically). J. S. Huxley was among the first to suggest that all such traits must be considered in classifying and identifying organisms (5). Electron microscopy and advances in biochemistry and genetics have greatly expanded the number of characters that can be considered in taxonomy, and the computer has facilitated the storage and evaluation of taxonomically important data (9).

PROBLEM:--Nematology is a relatively young science. Numerous previously-undescribed species are being discovered, and systems of classification are frequently in need of revision and improvement. One goal of the taxonomist is to devise systems that will have predictive value and will readily accommodate newly discovered species. Routine identification of nematodes is generally based solely on morphology, but ideally such identification should suggest information regarding host range, pathogenicity, and control. For example, if a root-knot nematode is identified as Meloidogyne incognita (Kofoid and White) Chitwood, we might predict that it will not survive on NC-95 tobacco, and that use of this resistant variety will effectively control the population<sup>2/</sup>. Similarly, if a regulatory agency identifies a nematode population as Radopholus similis (Cobb) Thorne (burrowing nematode), they generally infer that it will be destructive to citrus, and should not be introduced into an area where citrus is grown. Similar inferences might be made when a nematode population is identified as Tylenchulus semipenetrans Cobb, the citrus nematode.

Although predictions based on morphology alone are usually correct, we can be misled by nematode populations which look alike but behave differently. Thus, most M. incognita populations will not reproduce on the tobacco cultivar NC-95, but some nematodes, morphologically indistinguishable from common M. incognita, will attack NC-95 (6, 8). Similarly, identification of a nematode as R. similis does not permit one to predict with certainty that the nematode will reproduce on citrus. For example, DuCharme and Birchfield (4) observed that a burrowing nematode population from banana would not infect citrus, but that a morphologically indistinguishable population from citrus infected citrus and banana. The burrowing nematode reproduces on a number of ornamental hosts. These hosts, when infected, may be subject to quarantine even if the R. similis is a type which does not infect citrus. Unfortunately, routine morphological examination cannot yet distinguish among physiologically distinct populations of R. similis.

Identification of a nematode as T. semipenetrans cannot result in predicting with any certainty that the nematode will reproduce on citrus. Stokes and Langdon reported a population of T. semipenetrans on a grass host, Andropogon rhizomatus Swallen, which did not reproduce on citrus (10, 11). Yet, it was morphologically indistinguishable from populations which infect citrus. Thus, a plant infected with the citrus nematode, as one infected with the burrowing nematode, may be subject to regulatory action regardless of the host range of the nematode population.

---

<sup>1/</sup> Contribution No. N-153, Bureau of Nematology.

<sup>2/</sup> Population is defined as a group of organisms of a given locality, composed of individuals which may interbreed.

ASSESSMENT AND GOALS:--Morphologically indistinguishable populations which behave differently with respect to host range are generally referred to as pathotypes, biotypes, physiological races, or biological races. If such populations are reproductively isolated from one another they are generally considered to be sibling species (7). However, Mayr (7) has pointed out that once such species are discovered and carefully studied, minute morphological differences are usually found. Similarly, nematodes which have been thought to be different races of the same species, have later been observed to be sufficiently distinct in morphology to warrant description as separate species. For example, root-knot nematodes were previously classified as a single species. Christie and Albin (2) recognized several races on the basis of host range which were subsequently examined in morphological detail and described as separate species (3). Through such separation into morphologically distinct groups we are better able to predict host range on the basis of morphological characters. Yet we have pointed out that even within these species (viz M. incognita), physiologically different races exist. Will it eventually be possible to distinguish even finer differences, and thus, make more accurate predictions? Some investigators are using the scanning and transmission electron microscopes to search for minute details that might be correlated with host range. Other investigators have found races or groups of races that differ in chromosome number and are attempting to distinguish races serologically. Presently, many such methods are too complex for routine identification of nematodes, but we should not eliminate the possibility of future refinement and simplification of such methods to practical procedures. Often morphological characters observed with the electron microscope "sharpen our eyes", to look for, and detect the same characters with the light microscope. Such additional detailed investigations should help to elucidate the many problems related to taxonomy of nematodes. Additional investigations will improve our ability to classify and identify, and hopefully, will improve our ability to predict host range on the basis of morphology. Dr. G. W. Bird (1) reminds us that "the extent to which progress in other areas of nematology can proceed depends on a sound theory of systematics and proper taxonomic procedure".

#### Literature cited

1. Bird, G. W. 1971. Taxonomy: the science of classification. Pages 117-138 in B. M. Zuckerman, W. F. Mai, and R. A. Rohde, eds. Plant parasitic nematodes. Vol. I. Academic Press, New York.
2. Christie, J. R., and F. E. Albin. 1944. Host-parasite relationships of the root-knot nematode Heterodera marioni. I. The question of races. Proc. Helminthol. Soc. Wash. 11:31-37.
3. Chitwood, B. G. 1949. 'Root-knot nematodes' - Part 1. A revision of the genus Meloidogyne Goeldi, 1887. Proc. Helminthol. Soc. Wash. 16:90-104.
4. DuCharme, E. P., and W. Birchfield. 1956. Physiological races of the burrowing nematode. Phytopathology 46:615-616.
5. Huxley, J. S. 1940. The new systematics. Clarendon Press, Oxford. 583 p.
6. Kirby, M. R., D. W. Dickson, and G. C. Smart, Jr. 1975. Physiological variation within species of Meloidogyne occurring in Florida. Plant Dis. Repr. 59:353-356.
7. Mayr, E. 1969. Principles of systematic zoology. McGraw-Hill Book Co., New York. 428 p.
8. Perry, V. G., and J. A. Zeikus. 1972. Host variations among populations of the Meloidogyne incognita group. J. Nematol. 4:231-232 (Abstr.).
9. Sokal, R. R., and P. H. A. Sneath. 1963. Principles of numerical taxonomy. Freeman, San Francisco. 359 p.
10. Stokes, D. E., and K. R. Langdon. 1966. A grass host plant of the citrus nematode, Tylenchulus semipenetrans, and other associated plants. Plant Dis. Repr. 50:822-825.
11. Stokes, D. E. 1969. Andropogon rhizomatus parasitized by a strain of Tylenchulus semipenetrans not parasitic to four citrus rootstocks. Plant Dis. Repr. 53:882-885.